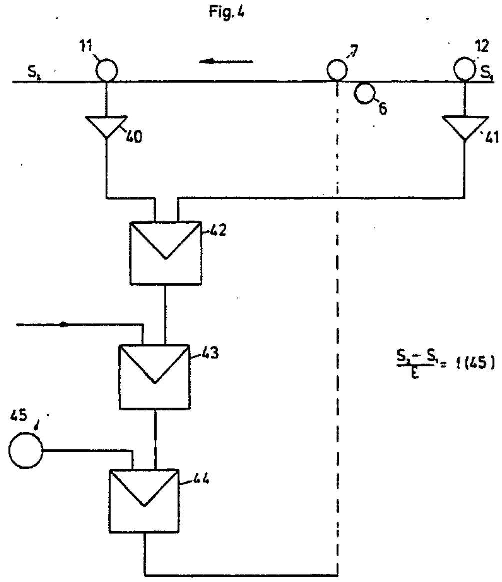
(12) UK Patent Application (19) GB (11) 2 045 129 A

(21) Application No 8009796
(22) Date of filing 24 Mar 1980
(30) Priority data
(31) 2911983
(32) 27 Mar 1979
(33) Fed. Rep of Germany (DE)
(43) Application published
29 Oct 1980
(51) INT CL[3]
B21D 1/05
(52) Domestic classification
B3E 10E1 14J 15T 8 K
(56) Documents cited
GB 1447781
(58) Field of search
B3E
(71) Applicants
Mannesmann Demag AG,
Wolfgang-Reuter-Platz,
D-4100 Duisburg,
Germany.
(72) Inventors
Helmut Grundig
(74) Agents
Brookes & Martin

(54) **Improvements in or relating to levelling of strip material**

(57) The control of position of a bending roll 7 of a device for stretch and roll levelling of metal strip is carried out by taking into account the degree of stretch, the tension in the strip and the bending work, using a control system to make comparisons between a predetermined desired value represented by a signal from a preset device 45 and a signal representing the actual value derived from measuring rolls 11, 12.

Fig. 4



GB 2 045 129 A

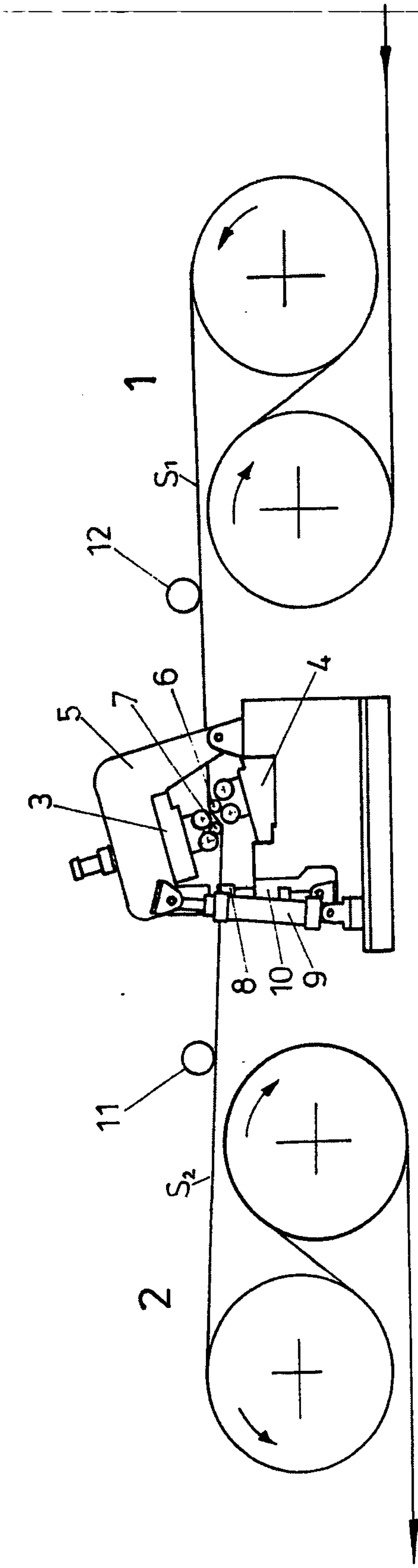


Fig.1

Fig. 2

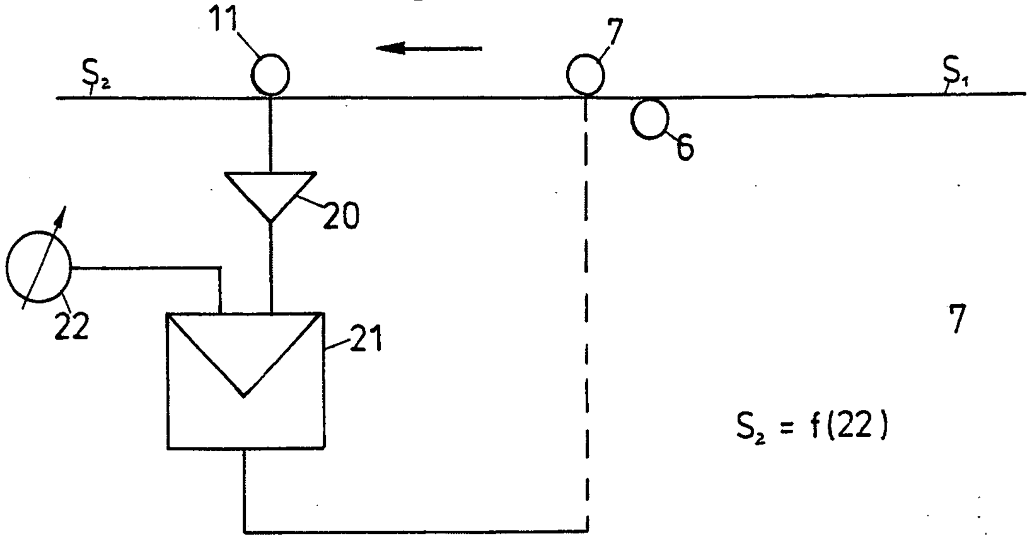

11
7
S_2
S_1
6
20
22
21
7
$S_2 = f(22)$

Fig. 3

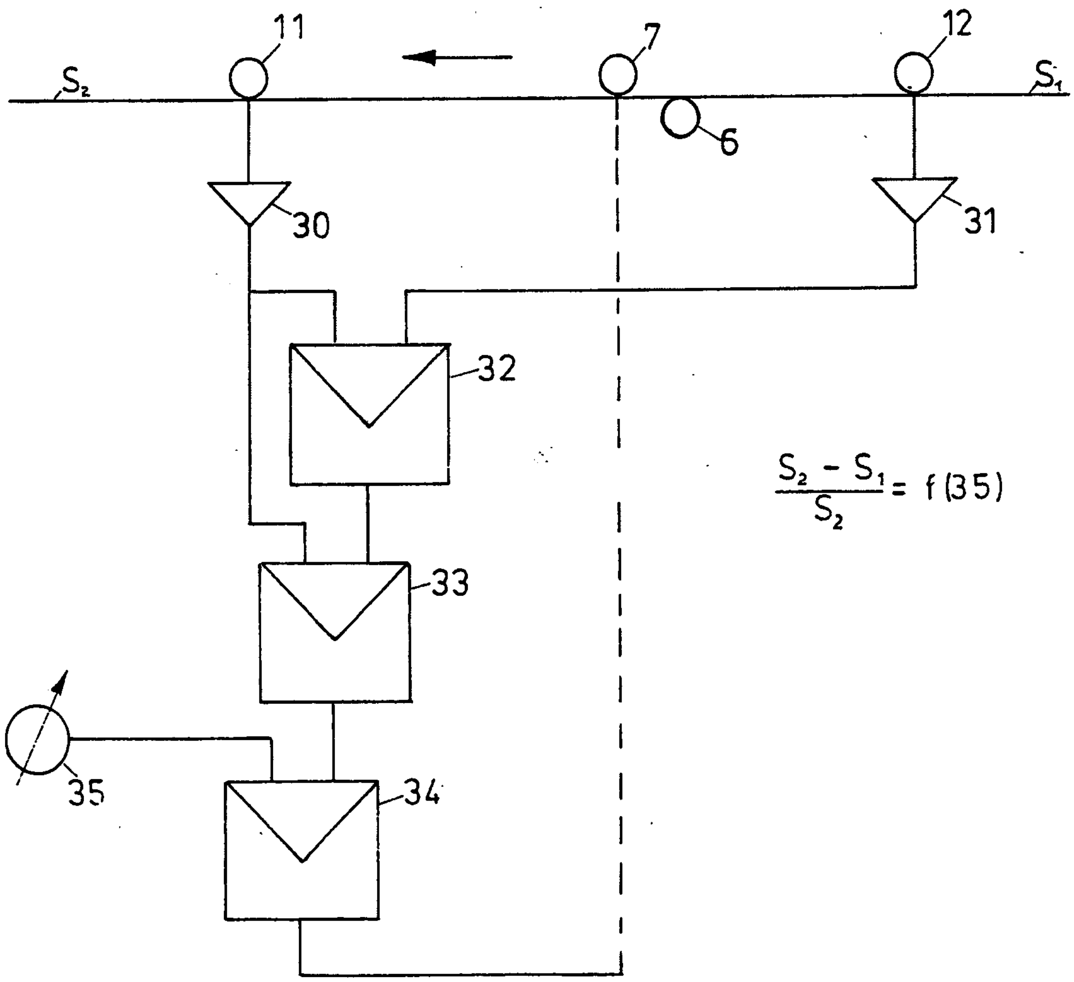
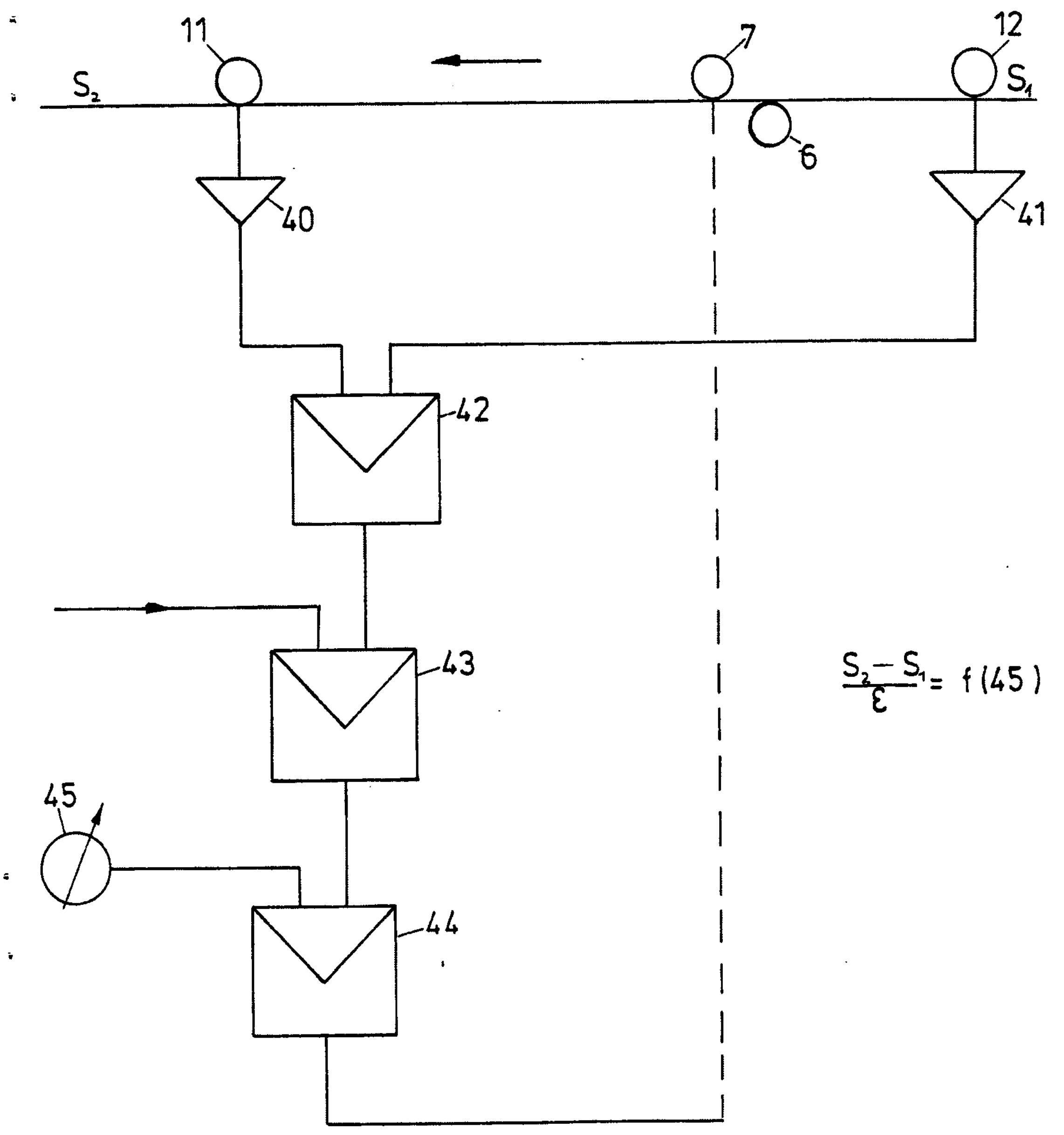

11
7
12
S_2
S_1
6
30
31
32
33
35
34
$\frac{S_2 - S_1}{S_2} = f(35)$

Fig. 4



SPECIFICATION

Improvements in or relating to levelling of strip material

This improvement relates to the levelling of metal strip using the so-called stretch and roll levelling method.

In stretch roller levelling, metal strip passes continuously through a device including two tensioning roll stands which are driven with a controlled speed difference to tension the strip by a predetermined amount. Arranged between the roll stands are bending rolls off-set relative to each other in the direction along the pass line. The rolls contact opposite sides of the strip which is thereby constrained to follow an undulating path. The bending rolls may be adjusted in the direction transversely of the strip to vary the degree to which the strip bends as it follows its path through the device.

Because it has been stretched and worked in this way, the strip emerging from the device is more free from inherent stresses and therefore more flat than the strip fed to the device. In addition, scale is removed from the surface strip and desired changes in the structure of the strip metal produced.

With the known devices, the preselected degree of stretch is controlled by adjusting the tension in the strip. This is achieved by using step-up gearing or superimposed gearing to mechanically vary the speed difference between th upstream and downstream tensioning roll stands. Devices are also known in which the strip tension is also predetermined by means of a speed difference and the corresponding degree of stretch is then produced.

The control means of the known devices do not always operate satisfactorily, in particular when the same device is used at different times to process strips made from different materials. In particular, this is because the main purpose of the known devices is to produce flat stip from strip which is uneven and has inherent stresses. The main function of the control means is therefore to prevent the strip from being loaded by excessive tensile stresses and thus rupturing at weak points. This means, however, that it is necessary to accept whatever degree of stretch the control means determines should be applied to the strip.

In the past, therefore, attention was paid mainly to achieving a desired standard of flatness of the strip, insufficient attention being paid to the structural change produced both in the structure of the strip itself and in that of any coating on the surface of the strip.

The tensioning of the strip also depends upon the work performed on the strip by the bending rolls, and this depends upon what may be referred to as the insertion depth of the bending rolls, that is, their positions relative to a mean strip pass line. Attempts have been made in the past to produce an optimum amount of bending, that is, as much bending as possible, to permit minimal tensioning. In this way, rupturing of the strip is avoided and the drive mechanisms of the tensioning rolls are subjected to less loading. In line with these attempts, the diameter of the bending rolls has been made as small as possible so as to constrain the strip to follow relatively sharp changes in direction.

An object of the present invention is to provide a process and device for stretch and roll levelling by which it is possible to produce a strip which is flat, having minimal stresses, and to effect in the strip a desired structural change.

This object is achieved by controlling the degree of stretch, tension and bending work applied to the strip, in combination. In accordance with the invention, the bending work is taken into account by the control means as a further parameter in addition to the degree of stretch and tension in the strip, in order to achieve optimum adaptation of the device to the respective requirements with regard to quality of the material and flatness of the strip. By controlling the operation in this way, it is possible to level strips of differing materials and cross-sections but to nevertheless achieve finished products having comparable properties.

The invention may be carried out using a control system including an electronic computer into which the mechanical data of a respective desired state resulting from the strip tension are fed as relatively constant values and the corresponding measured operating variables are fed as measured values, and in which differences and or quotients are formed between the constant values and the measured values, on the basis of which a control signal is produced for adjusting the insertion depth of the bending rolls.

As the bending work may be used as a relevant factor in controlling the levelling process, it is made use of by the control system by adjustment of the insertion depth of the bending rolls. The insertion depth of the bending rolls has a direct influence on the degree of stretch and tension in the strip, the tension being controlled by adjusting the insertion depth of the bending rolls. In addition to the known control circuit for the degree of stretch, there may thus be provided a second control system which, working with the strip tension, can be combined with the first control circuit so as to allow optimum adjustment of the device depending on the desired preselected constant values.

Preferably a preset constant value of the strip tension is compared with the actual strip tension and the control signal generated for adjusting the bending rolls is related to the resultant difference between the preset value and the actual value. The actual value may be determined by measuring the strip tension using for example a measuring roll bearing on the strip, and is compared with the preset value in the computer, the control signal for adjusting the bending roll being derived from the difference between the magnitudes of the signals.

The quotient of the bending work and tension work may be introduced as a relatively constant preset value which is compared with the corresponding actual values, and the control signal for adjustment of the bending rolls produced is related to the resultant difference between preset value and actual value. The bending work is produced from the difference in the tensile stresses upstream and

downstream of the bending rolls, and the tension work can be produced directly by the tensile stress. The degree of stretch is thus controlled and adjusted in the conventional way.

Finally, the quotient of the bending work and the degree of stretch may be introduced as a relatively constant preset value which is compared with the corresponding actual value, and the control signal for adjusting the bending rolls is related to the difference between the preset value and an actual value. With this solution the two control systems for the degree of stretch and the strip tension are combined, ie the degree of stretch is introduced directly into the computer so that the difference between the preset value and the actual value, on which is based the control signal for the adjustment of the bending rolls, takes into consideration the degree of stretch of the strip.

The invention allows a wide variety of strips to be processed to meet individual requirements, the improvement in the material being influenced particularly advantageously. Thus, for example, the invention allows galvanised strips to be processed with a small proportion of bending work so as to avoid excessive external stresses on the strip and thus on the zinc coating. At the same time, the invention allows the distribution of the bending and tension ratios to be selected and adjusted in a different way if necessary or desired, depending on the desired material properties.

The invention will now be described by way of example, with reference to the accompanying drawings, in which:

Figure 1 shows a schematic view of a stretch and roller levelling device,

Figure 2 shows a block circuit diagram of a control system for the device shown in Figure 1 taking into consideration strip tension,

Figure 3 shows a block circuit diagram of a control system for taking into consideration the bending and tension work, and,

Figure 4 shows a block circuit diagram of a control system for taking into consideration the degree of stretch and the bending.

Referring to the drawings, Figure 1 shows a stretch and roll levelling device of very simple design for levelling strip passing through the device in the direction of the arrows. The device comprises primarily a brake stand 1 and a tension stand 2, each provided with tensioning rolls about which the strip is passed, an upper bending coffer 3 and a lower bending coffer 4 supporting bending rolls 7 and 6 respectively. The upper bending coffer 3 is mounted in a pivotal frame movable about its pivot by means of a piston and cylinder unit 9. The extent of downward movement of the frame 5 is limited by stops 8 which therefore set the working position of the frame. The stops 8 are adjustable in both vertical directions by screws 10, turned by electric or hydraulic drive means. The insertion depth of the bending rolls 6 and 7 is therefore determined by appropriate adjustment of the stops 8, and the action of the piston and cylinder unit 9 causing the frame to bear against the stops. The magnitude of the strip tension S_1 and S_2 upstream and downstream of the bending rolls is determined using measuring rolls 12 and 11 respectively. The rolls of the stands 1 and 2 are driven at differential speeds to establish tension in the length of strip subjected to the effect of the bending rolls 6 and 7.

Figure 2 is a block circuit diagram of a control system (which may take the form of a computer) for controlling the tension S_2 in the strip leaving the bending rolls 6 and 7 by controlling the insertion depths of the bending rolls by adjustment of the end stops 8. The strip tension is measured directly on the strip passing through the device using the measuring roll 11. The signal generated by a transducer associated with the roll is fed via an amplifier 20 to a subtractor or comparator 21 which generates a signal representing the difference between the strip tension s_2 of the measuring roll 11 and a predetermined or preset desired strip tension the magnitude of which is represented by a signal generated by a device 22. The difference signal generated by the subtractor 21 constitutes a control signal for adjusting the insertion depth of the bending roll 7, as indicated in a broken line. The degree of stretch Σ is adjusted and controlled in a manner known per se, more specifically by superimposition of speed at the drive of the tensioning roll stands 1 and 2.

Figure 3 is a block circuit diagram of another control system. In this case, the quotient of the bending work which is determined by the tension difference ($S_2 - S_1$) upstream and downstream of the bending rolls and the tension work represented by the tension S_2 is controlled in combination with the degree of stretch. The subtractor or comparator 34 processes the values from the divider 33 and from the predetermined quotient (preset value) signal generated by device 35 to form the control signal for the adjustment of the bending roll 7.

Finally, Figure 4 shows another example. The quotient of bending work which is determined by the tension difference ($S_2 - S_1$) upstream and downstream of the bending rolls and the degree of stretch is formed using this control means. As in Figure 3, the subtractor or comparator produces a control signal for controlling the bending work from the signals of the strip tension measuring rolls 11 and 12 via the amplifiers 40 and 41, the resultant value being supplied to the divider 43 into which the corresponding value for the degree of stretch is simultaneously fed. The difference from the preset value signal derived from the device 45, from which the control signal for adjusting the bending roll 7 is, in turn, derived, is formed from these signals in the subtractor 44.

Reference is made to the specification of our copending Federal German application no P2911983, to the extent that the disclosure thereof differs from that of the present specification.

CLAIMS

1. A method of stretch and roll levelling of metal strip, wherein the strip passes continuously through two tension roll stands driven with a controllable speed difference, beween which stands the strip is subjected to the action of bending rolls which are

applied to opposite sides of the strip and are adjustable relative thereto, whereby the strip is tensioned lengthwise and constrained to follow an undulating path by the bending rolls, and wherein the degree of stretch, the tension in the strip and the bending work applied to the strip by the bending rolls are controlled in combination.

2. A device for stretch and roll levelling of metal strip, comprising upstream and downstream tension roll stands, means for driving said stands at differential speeds, and bending rolls located between said stands for contact with opposite sides of the strip, the bending rolls being adjustable relative to a mean strip pass line to constrain the strip to follow an undulating path, in combination with a control system into which the mechanical data of a respective desired state resulting from the strip tension are fed as relatively constant or preset values and the corresponding measured operating variables as measured values, and in which differences and or quotients are formed between the constant values and the measured values, on the basis of which a control signal is generated for adjusting the bending rolls.

3. A device as claimed in claim 2 including means for generating a signal indicative of the tension downstream of the bending rolls as a relatively constant or preset value, and means for comparing said signal with the measured strip tension (the actual value), the control pulse for adjusting the bending rolls being related to the resultant difference between the preset value and the actual value.

4. A device as claimed in claim 2, including means for generating a signal indicative of the quotient of the bending work (the difference between tensile stresses upstream and downstream of the bending rolls) and the tension work (the preset value), means for comparing said signal with the corresponding measured values, the control signal for adjusting the bending rolls being related to the resultant difference between the preset value and actual value.

5. A device as claimed in claim 2, including means for generating a signal indicative of the quotient of the bending work (difference between tensile stresses upstream and downstream of the bending rolls) and the degree of stretch Σ (the preset value), means for comparing said signal with the corresponding measured values, the control signal for adjusting the bending rolls being related to the resultant difference between preset value and actual value.

6. A method as claimed in claim 1 and substantially as hereinbefore described with reference to the accompanying drawings.

7. A device as claimed in claim 1 and substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

8. A method of stretch and roll levelling of metal strip, wherein the control of the relative positions of bending rolls applied to opposite sides of the strip so as to constrain strip already under tension to follow an undulating path is effected by using a control system to make comparisons between predetermined desired values of relevant parameters and actual measured values.

Printed for Her Majesty's Stationery Office by Croydon Printing Company Limited, Croydon Surrey, 1980.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

THIS PAGE BLANK (USPTO)